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LAMINATED PLASTIC ARTICLE

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Our invention relates to an improvement in laminated plastic articles and more particularly to an improved laminated plastic article and method of forming the same.

Metal armor has long been employed to protect personnel and materiel from injury resulting from flying fragments and missiles such as bullets and the like. This armor, however, suffers from a number of disadvantages. When employed as body armor to protect the person, it is extremely uncomfortable since it is heavy and is a good conductor of heat. Because it is rigid, it affords little freedom of movement. It is, moreover, difficult to form into shapes where it may conveniently be used as body armor. When used to form storage containers for protecting equipment, metal is too heavy to be practical for many uses. Owing to their liability to corrosion, such metal containers must themselves be protected. As a consequence, laminated plastic armors have been developed to replace metal armors. In our copending application, Serial No. 265,598, filed January 9, 1952, now Patent No. 2,778,761, we have disclosed a laminated plastic assembly for use as such an armor.

We have developed a laminated plastic article and method of forming the same which represent an improvement over the laminated plastic assembly shown in our said copending application, Serial No. 265,598. The improved article is extremely light in weight and is less bulky than similar articles formed of plastic armors of the prior art. Even so, our laminated plastic possesses improved ballistic properties. Then, too, it is provided with a barrier to the passage of vapor through the plastic assembly forming the article. We have also invented a method of forming and curing a number of laminates simultaneously to form an article which is resistant to penetration by flying fragments and missiles.

One object of our invention is to provide a laminated plastic article which is resistant to penetration by flying fragments, missiles, and the like.

Another object of our invention is to provide a laminated plastic article which is light in weight and which is less bulky than similar laminated plastic articles of the prior art.

Still another object of our invention is to provide a laminated plastic article provided with a barrier to the passage of vapor through the article wall.

A further object of our invention is to provide a method of forming an article which is resistant to penetration by flying fragments, missiles, and the like.

Yet another object of our invention is to provide a method of forming a laminated plastic article by molding and curing a number of plastic laminates simultaneously.

Other and further objects of our invention will appear from the following description.

In general, our invention contemplates the provision of a laminated plastic article formed from at least a pair of hard layers each comprising a fibrous material impregnated with a suitable plastic. We dispose a thin film of non-adherent material between the layers or laminates and cure the assembly at once. This film or films prevents the formation of a continuous bond over the surface between laminates during curing to ensure that laminates may shift relative to one another when subjected to forces resulting from the impact of a flying fragment or projectile or the like on the surface of the finished article. The film may be any impervious material

which is flexible, non-adherent and nonfusible at curing temperatures. When it is desired to bond the laminates one to another at spaced points, we perforate this film. Plastic seeps through the perforations during the forming and curing of the article to provide bonds over a minor portion of the surface between the laminates when the curing process is complete. If the article to be formed has a re-entrant cross section, no bonds may be necessary and the perforations may be eliminated. We have further provided a method by which a plurality of plastic impregnated laminates may be simultaneously molded and cured to provide an article which resists penetration by flying fragments, projectiles and the like.

In the accompanying drawings which form part of the instant specification and which are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views:

FIGURE 1 is a sectional view of our laminated plastic article with parts broken away, shown in a forming mold.

FIGURE 2 is a fragmentary sectional view drawn on an enlarged scale of our laminated plastic article, formed of four layers.

FIGURE 3 is a sectional view with a part broken away drawn on a reduced scale of another form of our laminated plastic article.

More particularly referring now to the drawings, our laminated plastic article includes a first laminate or layer **10** and a second layer or laminate **12**. As shown, the laminated plastic article is being formed as a protective helmet. It will be appreciated, of course, that while a helmet has been shown, any article of protective armor or a protective storage container or the like may be formed.

Each of the layers or laminates **10** and **12** may be formed of any appropriate matted, felted, woven, or braided fibrous material. Preferably, we employ spun glass fibers, but other material such as nylon or the like may be used. These laminates are impregnated with a suitable thermoplastic or thermo setting material. For example, such materials as polyethylene plastic, allyl plastic, polystyrene plastic, phenol formaldehyde compound, urea formaldehyde resins or the like may be used. preferably we employ a polyester resin, since this material may be cured at a temperature sufficiently low such that the film, to be described hereinafter, disposed between laminates will not fuse during curing.

In order to prevent the laminates from being bonded together over their entire contiguous surfaces during a curing operation, we dispose a thin film of non-adherent material **14** between adjacent laminates. This film may be any impervious material which remains flexible and does not fuse at the curing temperature employed. Such materials as cellophane, nylon, "Teflon," saran, cellulose acetate, or other such material may be used. "Teflon" is the registered trademark of E. I. du Pont de Nemours and Co. for a plastic consisting of a tetrafluoroethylene polymer. A thin metal film may also be used to separate adjacent laminates to prevent the formation of a continuous bond between adjacent laminates during a curing process. Preferably, we employ cellophane.

Where the configuration of the article being formed is such that the laminates would separate in the absence of a bond between adjacent laminates, we provide the film **14** with a number of spaced perforations **16**. During the curing process some of the viscous plastic impregnating material flows through the holes **16**. As a result, in the cured condition, a plurality of bonds **17** spaced over the surfaces of the laminates between adjacent laminates are provided. The spacing of these bonds **17** is such that adject laminates are firmly held in the assembled position. These bonds, however, cover only a minor portion of the